

glass being configured to be manufactured into a prestressed or transformed finished glass product; said method comprising:

(A) melting glass to provide a melt of molten glass;

(B) fining the melt of molten glass during melting in the absence of substantially both of (i.) and (ii.):

(i.) arsenic oxide; and

(ii.) antimony oxide;

to provide intermediate flat float glass comprising minimized surface treatment upon prestressing or transforming of the finished glass product;

(C) minimizing, in said intermediate flat float glass, the concentration of (a) and (b) to:

(a) less than 300 parts per billion of platinum (Pt); and

(b) less than 30 parts per billion of rhodium (Rh);

to minimize surface crystallization of said intermediate flat float glass;

(D) formulating the melt of molten glass to configure said intermediate flat float glass to contain (c) less than 1.5 weight percent zinc oxide (ZnO) to minimize crystal bands at the surface of said intermediate flat float glass;

(E) formulating the melt of molten glass to configure said intermediate flat float glass to contain (d) less than 1 weight percent of tin dioxide (SnO<sub>2</sub>) to minimize depressions or pits in the surface of said intermediate flat float glass;

said minimization of platinum (Pt) and rhodium (Rh) and said formulation of zinc oxide (ZnO) and tin dioxide (SnO<sub>2</sub>) thus minimizing surface defects during floating of said intermediate flat float glass;

(F) floating flat float glass from the melt of molten glass on a float medium to form said intermediate flat float glass; and

(G) removing said intermediate flat float glass from the float medium;

said intermediate flat float glass being configured to be transformable into all of (iii.), (iv.), and (v.):

(iii.) a prestressed flat float glass;

(iv.) a flat float glass transformed into a glass-ceramic comprising high quartz mixed crystals; and

(v.) a flat float glass transformed into a glass-ceramic comprising keatite mixed crystals.

26. The method according to claim 25, additionally comprising one of the following steps (H), (I), and (J):

(H.) prestressing said intermediate flat float glass to produce a prestressed flat float glass;

(I.) transforming said intermediate flat float glass into a glass-ceramic comprising high quartz mixed crystals; and

(J.) transforming said intermediate flat float glass into a glass-ceramic comprising keatite mixed crystals.

27. The method according to claim 26, wherein said intermediate flat float glass comprises a lithium oxide - aluminum oxide - silicon dioxide glass.

28. The method according to claim 27, wherein said intermediate flat float glass contains in weight percent on an oxide basis:

|  |            |
|--|------------|
| lithium oxide ( $\text{LiO}_2$ )           | 3.2-5.0;   |
| aluminum oxide ( $\text{Al}_2\text{O}_3$ ) | 19-25; and |
| silicon dioxide ( $\text{SiO}_2$ )         | 55-69.     |

B 29. The method according to claim 28, wherein said intermediate flat float glass further contains in weight percent on an oxide basis:

|  |         |
|--|---------|
| sodium oxide ( $\text{Na}_2\text{O}$ )   | 0-1.5   |
| potassium oxide ( $\text{K}_2\text{O}$ )   | 0-1.5   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ )<br>+ potassium oxide ( $\text{K}_2\text{O}$ )                   | 0.2-2.0 |
| magnesium oxide ( $\text{MgO}$ )   | 0.1-2.2 |
| calcium oxide ( $\text{CaO}$ )   | 0-1.5   |
| strontium oxide ( $\text{SrO}$ )   | 0-1.5   |
| barium oxide ( $\text{BaO}$ )  | 0-2.5   |
| zinc oxide ( $\text{ZnO}$ )  | 0-1.5   |
| titanium dioxide ( $\text{TiO}_2$ )  | 1.0-5.0 |
| zirconium dioxide ( $\text{ZrO}_2$ )   | 1.0-2.5 |
| tin dioxide ( $\text{SnO}_2$ )   | 0-1.0   |
| with the sum of titanium dioxide ( $\text{TiO}_2$ ) + zirconium ( $\text{ZrO}_2$ )<br>+ tin dioxide ( $\text{SnO}_2$ ) | 2.5-5.0 |
| phosphoric oxide ( $\text{P}_2\text{O}_5$ )  | 0-3.0.  |

30. The method according to claim 29, comprising:  
melting said molten glass in melting equipment being substantially free of: platinum and rhodium, to minimize the content of platinum (Pt) in said intermediate flat float glass to 300 parts per billion, and to minimize the content of rhodium (Rh) in said intermediate flat float glass to 30 parts per billion.

B 31. The method according to claim 30 comprising at least one of (i.), (ii.), (iii.), (iv.), and (v.):

(i.) minimizing the number of bubbles, or seeds, by adding to the melt of molten glass at least one chemical fining agent comprising: tin oxide ( $\text{SnO}_2$ ), cerium oxide ( $\text{CeO}_2$ ), sulfate compounds, and chloride compounds;

(ii.) adding to the melt of molten glass of from 0.2 to 0.6 weight percent of tin oxide;

(iii.) minimizing the number of bubbles in the glass melt by physically fining the glass melt by one of:

an underpressure; and

heating the melt to a temperature greater than 1750 degrees Celsius;

(iv.) adding a coloring agent comprising at least one compound of: vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), copper (Cu), nickel (Ni), selenium (Se), and/or chlorine (Cl); and

(v.) additionally comprising all of the following steps (a.), (b.), and (c.):

(a.) prestressing a first portion of said intermediate flat float glass to produce a prestressed flat float glass;

(b.) transforming a second portion of said intermediate flat float glass into a glass-ceramic comprising high quartz mixed crystals; and

(c.) transforming a third portion of said intermediate flat float glass into a glass-ceramic comprising keatite mixed crystals.

B/ 32. An intermediate flat float glass being configured to be prestressable, also being configured to be transformable into a glass-ceramic comprising high quartz mixed crystals, and also being configured to be transformable into a glass-ceramic comprising keatite mixed crystals, said intermediate flat float glass being configured to be manufactured into a prestressed finished glass product or a transformed finished glass product;

said intermediate flat float glass containing:

(a) less than 300 parts per billion of platinum (Pt); and

(b) less than 30 parts per billion of rhodium (Rh);

to minimize surface crystallization;

said intermediate flat float glass containing (c) less than 1.5 weight percent zinc oxide (ZnO) to minimize surface crystal bands; and

said intermediate flat float glass containing (d) less than 1 weight percent of tin dioxide ( $\text{SnO}_2$ ) to minimize surface depressions or pits;

said intermediate flat float glass being configured to be prestressable, also being configured to be transformable into a glass-ceramic comprising high quartz mixed crystals, and also being configured to be transformable into a glass-ceramic comprising keatite mixed crystals; and

said intermediate flat float glass being configured to be manufactured into a prestressed finished glass product or a transformed finished glass product.

B 33. The intermediate flat float glass according to claim 32, wherein:

said intermediate float glass comprises refined glass;

said refined glass being substantially free of both of (i.) and (ii.):

(i.) arsenic oxide; and

(ii.) antimony oxide;

to minimize surface metallic coatings.

34. The intermediate flat float glass according to claim 33, wherein said intermediate flat float glass comprises a lithium oxide - aluminum oxide - silicon dioxide glass.

35. The intermediate flat float glass according to claim 34, wherein said intermediate flat float glass contains in weight percent on an oxide basis:

lithium oxide ( $\text{LiO}_2$ ) 3.2-5.0


aluminum oxide ( $\text{Al}_2\text{O}_3$ ) 19-25  
silicon dioxide ( $\text{SiO}_2$ ) 55-69.

36. The intermediate flat float glass according to claim 35, wherein said intermediate flat float glass further contains in weight percent on an oxide basis:

B /  
sodium oxide ( $\text{Na}_2\text{O}$ ) 0-1.5  
potassium oxide ( $\text{K}_2\text{O}$ ) 0-1.5  
with the sum of sodium oxide ( $\text{Na}_2\text{O}$ )  
+ potassium oxide ( $\text{K}_2\text{O}$ ) 0.2-2.0  
magnesium oxide ( $\text{MgO}$ ) 0.1-2.2  
calcium oxide ( $\text{CaO}$ ) 0-1.5  
strontium oxide ( $\text{SrO}$ ) 0-1.5  
barium oxide ( $\text{BaO}$ ) 0-2.5  
zinc oxide ( $\text{ZnO}$ ) 0-1.5  
titanium dioxide ( $\text{TiO}_2$ ) 1.0-5.0  
zirconium dioxide ( $\text{ZrO}_2$ ) 1.0-2.5  
tin dioxide ( $\text{SnO}_2$ ) 0-1.0  
with the sum of titanium dioxide ( $\text{TiO}_2$ ) + zirconium ( $\text{ZrO}_2$ ) +  
tin dioxide ( $\text{SnO}_2$ ) 2.5-5.0  
phosphoric oxide ( $\text{P}_2\text{O}_5$ ) 0-3.0.

37. The intermediate flat float glass according to claim 33, comprising one of (i.), (ii.), (iii.), (iv.), (v.), (vi.), (vii.), (viii.), (ix.), (x.), (xi.), (xii.), and (xiii.):

(i.) said intermediate flat float glass comprises in weight percent on an oxide basis a composition of:




|   |         |
|---|---------|
| lithium oxide ( $\text{Li}_2\text{O}$ )   | 3.2-5.0 |
| sodium oxide ( $\text{Na}_2\text{O}$ )  | 0-1.5   |
| potassium oxide ( $\text{K}_2\text{O}$ )  | 0-1.5   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ ) +<br>potassium oxide ( $\text{K}_2\text{O}$ )                              | 0.2-2.0 |
| magnesium oxide ( $\text{MgO}$ )  | 0.1-2.2 |
| calcium oxide ( $\text{CaO}$ )  | 0-1.5   |
| strontium oxide ( $\text{SrO}$ )  | 0-1.5   |
| barium oxide ( $\text{BaO}$ )   | 0-2.5   |
| zinc oxide ( $\text{ZnO}$ )   | 0-<1.5  |
| aluminum oxide ( $\text{Al}_2\text{O}_3$ )  | 19-25   |
| silicon dioxide ( $\text{SiO}_2$ )  | 55-69   |
| titanium dioxide ( $\text{TiO}_2$ )   | 1.0-5.0 |
| zirconium dioxide ( $\text{ZrO}_2$ )  | 1.0-2.5 |
| tin dioxide ( $\text{SnO}_2$ )  | 0-<1.0  |
| with the sum of titanium dioxide ( $\text{TiO}_2$ ) +<br>zirconium dioxide ( $\text{ZrO}_2$ ) +<br>tin dioxide ( $\text{SnO}_2$ ) | 2.5-5.0 |
| phosphoric oxide ( $\text{P}_2\text{O}_5$ )   | 0-3.0;  |

(ii.) said intermediate flat float glass comprises colored glass;  
said colored glass comprises a coloring agent;  
said coloring agent comprises at least one compound of:  
vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co),  
copper (Cu), nickel (Ni), selenium (Se), and chlorine (Cl);



(iii.) said intermediate flat float glass comprises in weight percent on an oxide basis a composition of:



|  |         |
|--|---------|
| lithium oxide ( $\text{Li}_2\text{O}$ )                  | 3.5-4.5 |
| sodium oxide ( $\text{Na}_2\text{O}$ )                   | 0.2-1.0 |
| potassium oxide ( $\text{K}_2\text{O}$ )                 | 0-0.8   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ ) + |         |
| potassium oxide ( $\text{K}_2\text{O}$ )                 | 0.4-1.5 |
| magnesium oxide ( $\text{MgO}$ )                         | 0.3-2.0 |
| calcium oxide ( $\text{CaO}$ )                           | 0-1.0   |
| strontium oxide ( $\text{SrO}$ )                         | 0-1.0   |
| barium oxide ( $\text{BaO}$ )                            | 0-2.5   |
| zinc oxide ( $\text{ZnO}$ )                              | 0-1.0   |
| aluminum oxide ( $\text{Al}_2\text{O}_3$ )               | 19-24   |
| silicon dioxide ( $\text{SiO}_2$ )                       | 60-68   |
| titanium dioxide ( $\text{TiO}_2$ )                      | 1.0-2.0 |
| zirconium dioxide ( $\text{ZrO}_2$ )                     | 1.2-2.2 |
| tin dioxide ( $\text{SnO}_2$ )                           | 0-0.6   |
| with the sum of titanium dioxide ( $\text{TiO}_2$ ) +    |         |
| zirconium dioxide ( $\text{ZrO}_2$ ) +                   |         |
| tin dioxide ( $\text{SnO}_2$ )                           | 3.0-4.5 |
| phosphoric oxide ( $\text{P}_2\text{O}_5$ )              | 0-2.0;  |

(iv.) said intermediate flat float glass comprises glass being configured to be chemically prestressable; and

the sum of the percentage of lithium oxide ( $\text{Li}_2\text{O}$ ) and the percentage of sodium oxide ( $\text{Na}_2\text{O}$ ) being greater than 3.5 percent by weight based on oxide;

(v.) said intermediate flat float glass comprises chemically prestressable glass;

(vi.) said intermediate flat float glass comprises:

the sum of 3.2 times the percentage of zinc oxide (ZnO) and the percentage of titanium dioxide (TiO<sub>2</sub>) being equal to or less than 4.3 weight percent based on oxide to minimize surface crystal bands;

(vii.) said intermediate flat float glass comprises:

less than 200 parts per million iron oxide (Fe<sub>2</sub>O<sub>3</sub>); and less than 2.5 weight percent of titanium dioxide (TiO<sub>2</sub>), on an oxide basis;

to minimize coloration due to iron oxide and titanium dioxide upon vitrification of said intermediate flat float glass;

(viii.) said intermediate flat float glass comprises glass being configured to have, at a thickness of 4 millimeters, light transmittances of one of:

more than 89 percent; and

more than 90 percent;

(ix.) said intermediate flat float glass being substantially free of:  
zinc oxide (ZnO); and  
barium oxide (BaO);

(x.) said intermediate flat float glass is configured to have:  
a coefficient of thermal expansion  $\alpha_{20/300}$  between 3.5 millionths per degree Kelvin and 5.0 millionths per degree Kelvin;

a transformation temperature  $T_g$  between 600 and 750 degrees Celsius; and

a processing temperature  $V_A$  below 1350 degrees Celsius;

(xi.) said intermediate flat float glass comprises one of:

(a.) an intermediate flat float glass being configured to be transformable into one of:

a transparent glass-ceramic;

a translucent glass-ceramic; and

an opaque glass-ceramic;

(b.) an intermediate flat float glass being configured to be transformable into a glass-ceramic comprising keatite mixed crystals as the predominant crystal phase and said intermediate flat float glass being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  of less than 1.5 millionths per degree Kelvin;

(c.) an intermediate flat float glass being configured to be transformable into a glass-ceramic comprising high quartz mixed crystals as the predominant crystal phase and said intermediate flat float glass being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  in the range of one of:

from minus 0.5 five millionths per degree Kelvin to

0.5 millionths per degree Kelvin; and

minus 0.15 millionths per degree Kelvin to 0.15

millionths per degree Kelvin;

(xii.) said intermediate flat float glass comprises an intermediate flat float glass transformable into a transparent glass-ceramic;

said glass-ceramic comprising in weight percent based on oxide:

B ( less than 2 percent of titanium dioxide ( $\text{TiO}_2$ );  
less than 0.5 percent of tin dioxide ( $\text{SnO}_2$ ); and  
less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and  
said glass-ceramic being configured to have a light  
transmittance, at 4 millimeters thickness, of less than eighty percent;  
(xiii.) said intermediate flat float glass comprises an intermediate  
flat float glass being configured to be transformable into a glass-  
ceramic;

said glass-ceramic being colored with a coloring agent  
comprising at least one compound of: vanadium (V), chromium (Cr),  
manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni);

said glass-ceramic being configured to have a light transmittance  
of less than five percent at a thickness of 4 millimeters.

38. The intermediate flat float glass according to claim 33,  
comprising all of: (i.), (ii.), (iii.), (iv.), (v.), and (vi.):

(i.) one of (a.) and (b.):

(a.) said intermediate flat float glass comprises in weight  
percent on an oxide basis a composition of:


|  |         |
|--|---------|
| lithium oxide ( $\text{Li}_2\text{O}$ )  | 3.2-5.0 |
| sodium oxide ( $\text{Na}_2\text{O}$ )   | 0-1.5   |
| potassium oxide ( $\text{K}_2\text{O}$ )   | 0-1.5   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ ) +<br>potassium oxide ( $\text{K}_2\text{O}$ ) | 0.2-2.0 |
| magnesium oxide ( $\text{MgO}$ )   | 0.1-2.2 |
| calcium oxide ( $\text{CaO}$ )   | 0-1.5   |

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strontium oxide (SrO) 0-1.5  
barium oxide (BaO) 0-2.5  
zinc oxide (ZnO) 0-<1.5  
aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) 19-25  
silicon dioxide (SiO<sub>2</sub>) 55-69  
titanium dioxide (TiO<sub>2</sub>) 1.0-5.0  
zirconium dioxide (ZrO<sub>2</sub>) 1.0-2.5  
tin dioxide (SnO<sub>2</sub>) 0-<1.0

with the sum of titanium dioxide (TiO<sub>2</sub>) +  
zirconium dioxide (ZrO<sub>2</sub>) +  
tin dioxide (SnO<sub>2</sub>) 2.5-5.0  
phosphoric oxide (P<sub>2</sub>O<sub>5</sub>) 0-3.0; and

(b.) said intermediate flat float glass comprises in weight percent on an oxide basis a composition of:

lithium oxide (Li<sub>2</sub>O) 3.5-4.5  
sodium oxide (Na<sub>2</sub>O) 0.2-1.0  
potassium oxide (K<sub>2</sub>O) 0-0.8  
with the sum of sodium oxide (Na<sub>2</sub>O) +  
potassium oxide (K<sub>2</sub>O) 0.4-1.5  
magnesium oxide (MgO) 0.3-2.0  
calcium oxide (CaO) 0-1.0  
strontium oxide (SrO) 0-1.0  
barium oxide (BaO) 0-2.5  
zinc oxide (ZnO) 0-1.0  
aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) 19-24  
silicon dioxide (SiO<sub>2</sub>) 60-68



|   |         |
|---|---------|
| titanium dioxide ( $\text{TiO}_2$ )   | 1.0-2.0 |
| zirconium dioxide ( $\text{ZrO}_2$ )  | 1.2-2.2 |
| tin dioxide ( $\text{SnO}_2$ )  | 0-0.6   |
| with the sum of titanium dioxide ( $\text{TiO}_2$ ) +<br>zirconium dioxide ( $\text{ZrO}_2$ ) +<br>tin dioxide ( $\text{SnO}_2$ ) | 3.0-4.5 |
| phosphoric oxide ( $\text{P}_2\text{O}_5$ )   | 0-2.0;  |

(ii.) said intermediate flat float glass comprises the sum of 3.2 times the percentage of zinc oxide ( $\text{ZnO}$ ) and the percentage of titanium dioxide ( $\text{TiO}_2$ ) being equal to or less than 4.3 weight percent based on oxide to minimize surface crystal bands;

(iii.) said intermediate flat float glass comprises:  
less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and  
less than 2.5 weight percent of titanium dioxide ( $\text{TiO}_2$ ), on an oxide basis;


to minimize coloration due to iron oxide and titanium dioxide upon vitrification of said intermediate flat float glass;

(iv.) said intermediate flat float glass comprises glass configured to have, at a thickness of 4 millimeters, light transmittances of one of:

more than 89 percent; and  
more than 90 percent;

(v.) said intermediate flat float glass being substantially free of:  
zinc oxide ( $\text{ZnO}$ ); and  
barium oxide ( $\text{BaO}$ );

(vi.) said intermediate flat float glass is configured to have:

 a coefficient of thermal expansion  $\alpha_{20/300}$  between 3.5 millionths per degree Kelvin and 5.0 millionths per degree Kelvin;

a transformation temperature  $T_g$  between 600 and 750 degrees Celsius; and

a processing temperature  $V_A$  below 1350 degrees Celsius.

39. The intermediate flat float glass according to claim 38 comprising one of (viii.), (ix.), (x.), (xi.), and (xii.):

(viii.) said intermediate flat float glass comprises colored glass;  
said colored glass comprises a coloring agent;

said coloring agent comprising at least one compound of:  
vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co),  
copper (Cu), nickel (Ni), selenium (Se), and chlorine (Cl);

(ix.) said intermediate flat float glass comprises one of:

(a.) an intermediate flat float glass being configured to be transformable into one of:

- a transparent glass-ceramic;
- a translucent glass-ceramic; and
- an opaque glass-ceramic;

(b.) an intermediate flat float glass being configured to be transformable into a glass-ceramic comprising keatite mixed crystals as the predominant crystal phase and said intermediate flat float glass being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  of less than 1.5 millionths per degree Kelvin;

(c.) an intermediate flat float glass being configured to be transformable into a glass-ceramic comprising high quartz mixed crystals as the predominant crystal phase and said intermediate flat float glass being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  in the range of one of:

from minus 0.5 five millionths per degree Kelvin to 0.5 millionths per degree Kelvin; and

minus 0.15 millionths per degree Kelvin to 0.15

millionths per degree Kelvin;

(x.) said intermediate flat float glass comprises an intermediate flat float glass configured to be transformable into a transparent glass-ceramic;

said glass-ceramic comprising in weight percent based on oxide:

less than 2 percent of titanium dioxide ( $\text{TiO}_2$ );

less than 0.5 percent of tin dioxide ( $\text{SnO}_2$ ); and

less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and

said glass-ceramic being configured to have a light

transmittance, at 4 millimeters thickness, of less than eighty percent;

(xi.) said intermediate flat float glass comprises an intermediate flat float glass being configured to be transformable into a glass-ceramic;

said glass-ceramic being colored with a coloring agent comprising at least one compound of: vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni);

said glass-ceramic being configured to have a light transmittance of less than five percent at a thickness of 4 millimeters; and



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(xii.) said intermediate flat float glass comprises glass being configured to be chemically prestressable;

said chemically prestressable glass comprises the sum of the percentage of lithium oxide ( $\text{Li}_2\text{O}$ ) and the percentage of sodium oxide ( $\text{Na}_2\text{O}$ ) being greater than 3.5 percent by weight based on oxide.

40. A finished float glass product, comprising at least one of:  
a transparent glass-ceramic fireproof glass, a transparent glass-ceramic oven view window, a transparent glass-ceramic pyrolysis oven window, a transparent glass-ceramic stove window, a transparent glass-ceramic furnace window, a transparent glass-ceramic item of cookware, a transparent glass-ceramic wafer substrate material, a transparent glass-ceramic telescope, mirror, a transparent glass-ceramic high-energy light cover, a thermally prestressed fireproof glass, a chemically prestressed fireproof glass, a colored glass-ceramic cooking heating plate, and a colored glass-ceramic grilling heating plate;

said finished float glass product containing:

less than 300 parts per billion of platinum (Pt); and

less than 30 parts per billion of rhodium (Rh);

to minimize surface crystallization;

less than 1.5 weight percent zinc oxide ( $\text{ZnO}$ ) to minimize surface crystal bands; and

less than 1 weight percent of tin dioxide ( $\text{SnO}_2$ ) to minimize surface depressions or pits; and

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said finished float glass product containing lithium oxide -  
aluminum oxide - silicon dioxide.

41. The finished float glass product according to claim 40,  
comprising one of (i.), (ii.), (iii.), (iv.), (v.), (vi.), (vii.), (viii.), (ix.),  
(x.), (xi.), (xii.), and (xiii.):

(i.) said finished float glass product comprises in weight percent  
on an oxide basis a composition of:

|   |         |
|---|---------|
| lithium oxide ( $\text{Li}_2\text{O}$ )   | 3.2-5.0 |
| sodium oxide ( $\text{Na}_2\text{O}$ )  | 0-1.5   |
| potassium oxide ( $\text{K}_2\text{O}$ )  | 0-1.5   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ ) +<br>potassium oxide ( $\text{K}_2\text{O}$ )                              | 0.2-2.0 |
| magnesium oxide ( $\text{MgO}$ )  | 0.1-2.2 |
| calcium oxide ( $\text{CaO}$ )  | 0-1.5   |
| strontium oxide ( $\text{SrO}$ )  | 0-1.5   |
| barium oxide ( $\text{BaO}$ )   | 0-2.5   |
| zinc oxide ( $\text{ZnO}$ )   | 0-<1.5  |
| aluminum oxide ( $\text{Al}_2\text{O}_3$ )  | 19-25   |
| silicon dioxide ( $\text{SiO}_2$ )  | 55-69   |
| titanium dioxide ( $\text{TiO}_2$ )   | 1.0-5.0 |
| zirconium dioxide ( $\text{ZrO}_2$ )  | 1.0-2.5 |
| tin dioxide ( $\text{SnO}_2$ )  | 0-<1.0  |
| with the sum of titanium dioxide ( $\text{TiO}_2$ ) +<br>zirconium dioxide ( $\text{ZrO}_2$ ) +<br>tin dioxide ( $\text{SnO}_2$ ) | 2.5-5.0 |

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phosphoric oxide ( $P_2O_5$ ) 0-3.0;

(ii.) said finished float glass product comprises colored glass;

said colored glass comprises a coloring agent;

said coloring agent comprises at least one compound of:

vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co),  
copper (Cu), nickel (Ni), selenium (Se), and chlorine (Cl);

(iii.) said finished float glass product comprises in weight  
percent on an oxide basis a composition of:

lithium oxide ( $Li_2O$ ) 3.5-4.5

sodium oxide ( $Na_2O$ ) 0.2-1.0

potassium oxide ( $K_2O$ ) 0-0.8

with the sum of sodium oxide ( $Na_2O$ ) +

potassium oxide ( $K_2O$ ) 0.4-1.5

magnesium oxide ( $MgO$ ) 0.3-2.0

calcium oxide ( $CaO$ ) 0-1.0

strontium oxide ( $SrO$ ) 0-1.0

barium oxide ( $BaO$ ) 0-2.5

zinc oxide ( $ZnO$ ) 0-1.0

aluminum oxide ( $Al_2O_3$ ) 19-24

silicon dioxide ( $SiO_2$ ) 60-68

titanium dioxide ( $TiO_2$ ) 1.0-2.0

zirconium dioxide ( $ZrO_2$ ) 1.2-2.2

tin dioxide ( $SnO_2$ ) 0-0.6

with the sum of titanium dioxide ( $TiO_2$ ) +

zirconium dioxide ( $ZrO_2$ ) +

tin dioxide ( $SnO_2$ ) 3.0-4.5

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phosphoric oxide ( $P_2O_5$ )

0-2.0;

(iv.) said finished float glass product comprises chemically prestressed float glass;

said chemically prestressed glass comprises: the sum of the percentage of lithium oxide ( $Li_2O$ ) and the percentage of sodium oxide ( $Na_2O$ ) being greater than 3.5 percent by weight based on oxide;

(v.) said finished float glass product comprises chemically prestressed glass;

(vi.) said finished float glass product comprises:

the sum of 3.2 times the percentage of zinc oxide ( $ZnO$ ) and the percentage of titanium dioxide ( $TiO_2$ ) being equal to or less than 4.3 weight percent based on oxide;

to minimize surface crystal bands;

(vii.) said finished float glass product comprises:

less than 200 parts per million iron oxide ( $Fe_2O_3$ ); and less than 2.5 weight percent of titanium dioxide ( $TiO_2$ ), on an oxide basis;

to minimize coloration due to iron oxide and titanium dioxide upon vitrification of said intermediate flat float glass;

(viii.) said finished float glass product comprises glass being configured to have, at a thickness of 4 millimeters, light transmittances of one of:

more than 89 percent; and

more than 90 percent;

(ix.) said finished float glass product being substantially free of: zinc oxide ( $ZnO$ ); and

barium oxide (BaO);

(x.) said finished float glass product is configured to have:

a coefficient of thermal expansion  $\alpha_{20/300}$  between 3.5 millionths per degree Kelvin and 5.0 millionths per degree Kelvin;

a transformation temperature  $T_g$  between 600 and 750 degrees Celsius; and

a processing temperature  $V_A$  below 1350 degrees Celsius;

(xi.) said finished float glass product comprises one of:

(a.) a finished float glass product comprising one of:

a transparent glass-ceramic;

a translucent glass-ceramic; and

an opaque glass-ceramic;

(b.) a glass-ceramic comprising keatite mixed crystals as the predominant crystal phase and said glass-ceramic being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  of less than 1.5 millionths per degree Kelvin;

(c.) a glass-ceramic comprising high quartz mixed crystals as the predominant crystal phase and said glass-ceramic being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  in the range of one of:

from minus 0.5 five millionths per degree Kelvin to 0.5 millionths per degree Kelvin; and

minus 0.15 millionths per degree Kelvin to 0.15 millionths per degree Kelvin;

(xii.) said finished float glass product comprises a transparent glass-ceramic comprising in weight percent based on oxide:

1  
B less than 2 percent of titanium dioxide ( $\text{TiO}_2$ );  
less than 0.5 percent of tin dioxide ( $\text{SnO}_2$ ); and  
less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and  
said glass-ceramic being configured to have a light  
transmittance, at 4 millimeters thickness, of less than eighty percent;

(xiii.) said finished float glass product comprises a glass-ceramic  
being colored with a coloring agent comprising at least one compound  
of: vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt  
(Co), nickel (Ni);

said colored glass-ceramic being configured to have a light  
transmittance of less than five percent at a thickness of 4 millimeters.

42. The finished float glass product according to claim 40,  
comprising all of: (i.), (ii.), (iii.), (iv.), (v.), and (vi.):

(i.) one of (a.) and (b.):

(a.) said finished float glass product comprises in weight  
percent on an oxide basis a composition of:

|  |         |
|--|---------|
| lithium oxide ( $\text{Li}_2\text{O}$ )  | 3.2-5.0 |
| sodium oxide ( $\text{Na}_2\text{O}$ )   | 0-1.5   |
| potassium oxide ( $\text{K}_2\text{O}$ )   | 0-1.5   |
| with the sum of sodium oxide ( $\text{Na}_2\text{O}$ ) +<br>potassium oxide ( $\text{K}_2\text{O}$ ) | 0.2-2.0 |
| magnesium oxide ( $\text{MgO}$ )   | 0.1-2.2 |
| calcium oxide ( $\text{CaO}$ )   | 0-1.5   |
| strontium oxide ( $\text{SrO}$ )   | 0-1.5   |
| barium oxide ( $\text{BaO}$ )  | 0-2.5   |

zinc oxide (ZnO) 0-<1.5  
aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) 19-25  
silicon dioxide (SiO<sub>2</sub>) 55-69  
titanium dioxide (TiO<sub>2</sub>) 1.0-5.0  
zirconium dioxide (ZrO<sub>2</sub>) 1.0-2.5  
tin dioxide (SnO<sub>2</sub>) 0-<1.0  
with the sum of titanium dioxide (TiO<sub>2</sub>) +  
zirconium dioxide (ZrO<sub>2</sub>) +  
tin dioxide (SnO<sub>2</sub>) 2.5-5.0  
phosphoric oxide (P<sub>2</sub>O<sub>5</sub>) 0-3.0;

(b.) said finished float glass product comprises in weight percent on an oxide basis a composition of:

lithium oxide (Li<sub>2</sub>O) 3.5-4.5  
sodium oxide (Na<sub>2</sub>O) 0.2-1.0  
potassium oxide (K<sub>2</sub>O) 0-0.8  
with the sum of sodium oxide (Na<sub>2</sub>O) +  
potassium oxide (K<sub>2</sub>O) 0.4-1.5  
magnesium oxide (MgO) 0.3-2.0  
calcium oxide (CaO) 0-1.0  
strontium oxide (SrO) 0-1.0  
barium oxide (BaO) 0-2.5  
zinc oxide (ZnO) 0-1.0  
aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) 19-24  
silicon dioxide (SiO<sub>2</sub>) 60-68  
titanium dioxide (TiO<sub>2</sub>) 1.0-2.0  
zirconium dioxide (ZrO<sub>2</sub>) 1.2-2.2

tin dioxide ( $\text{SnO}_2$ ) 0-0.6  
with the sum of titanium dioxide ( $\text{TiO}_2$ ) +  
zirconium dioxide ( $\text{ZrO}_2$ ) +  
tin dioxide ( $\text{SnO}_2$ ) 3.0-4.5  
phosphoric oxide ( $\text{P}_2\text{O}_5$ ) 0-2.0;

(ii.) said finished float glass product comprises:

the sum of 3.2 times the percentage of zinc oxide ( $\text{ZnO}$ )  
and the percentage of titanium dioxide ( $\text{TiO}_2$ ) being equal to or  
less than 4.3 weight percent based on oxide;  
to minimize surface crystal bands;

(iii.) said finished float glass product comprises:

less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and  
less than 2.5 weight percent of titanium dioxide ( $\text{TiO}_2$ ), on an oxide  
basis;

to minimize coloration due to iron oxide and titanium  
dioxide upon vitrification;

(iv.) said finished float glass product comprises glass configured  
to have, at a thickness of 4 millimeters, light transmittances of one  
of:

more than 89 percent; and  
more than 90 percent;

(v.) said finished float glass product being substantially free of:  
zinc oxide ( $\text{ZnO}$ ); and  
barium oxide ( $\text{BaO}$ );

(vi.) said finished float glass product is configured to have:



a coefficient of thermal expansion  $\alpha_{20/300}$  between 3.5 millionths per degree Kelvin and 5.0 millionths per degree Kelvin;

a transformation temperature  $T_g$  between 600 and 750 degrees Celsius; and

a processing temperature  $V_A$  below 1350 degrees Celsius.

43. The finished float glass product according to claim 42 comprising one of (viii.), (ix.), (x.), (xi.), and xii.):

(viii.) said finished float glass product comprises colored glass;  
said colored glass comprises a coloring agent;

said coloring agent comprising at least one compound of:  
vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt (Co),  
copper (Cu), nickel (Ni), selenium (Se), and chlorine (Cl);

(ix.) said finished float glass product comprises one of:

- (a.) a transparent glass-ceramic;  
a translucent glass-ceramic; and  
an opaque glass-ceramic;

(b.) a glass-ceramic comprising keatite mixed crystals as the predominant crystal phase and said glass-ceramic being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  of less than 1.5 millionths per degree Kelvin;

(c.) a glass-ceramic comprising high quartz mixed crystals as the predominant crystal phase and said glass-ceramic being configured to have a coefficient of thermal expansion  $\alpha_{20/700}$  in the range of one of:

from minus 0.5 five millionths per degree Kelvin to  
0.5 millionths per degree Kelvin; and  
minus 0.15 millionths per degree Kelvin to 0.15  
millionths per degree Kelvin;

(x.) said finished float glass product comprises a transparent  
glass-ceramic comprising in weight percent based on oxide:  
less than 2 percent of titanium dioxide ( $\text{TiO}_2$ );  
less than 0.5 percent of tin dioxide ( $\text{SnO}_2$ ); and  
less than 200 parts per million iron oxide ( $\text{Fe}_2\text{O}_3$ ); and  
said glass-ceramic being configured to have a light  
transmittance, at 4 millimeters thickness, of less than eighty percent;

(xi.) said finished float glass product comprises a glass-ceramic  
being colored with a coloring agent comprising at least one compound  
of: vanadium (V), chromium (Cr), manganese (Mn), iron (Fe), cobalt  
(Co), nickel (Ni);

said colored glass-ceramic being configured to have a light  
transmittance of less than five percent at a thickness of 4 millimeters;  
and

(xii.) said finished float glass product comprises chemically  
prestressed glass;

said chemically prestressed glass comprises:  
the sum of the percentage of lithium oxide ( $\text{Li}_2\text{O}$ ) and the  
percentage of sodium oxide ( $\text{Na}_2\text{O}$ ) being greater than 3.5 percent by  
weight based on oxide.